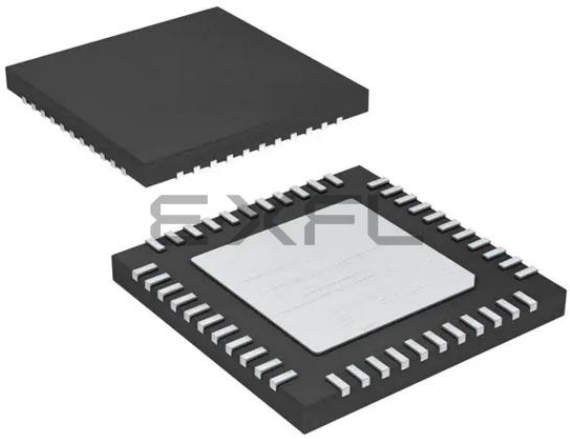
Microchip Technology - DSPIC33EP32MC204T-E/ML Datasheet



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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

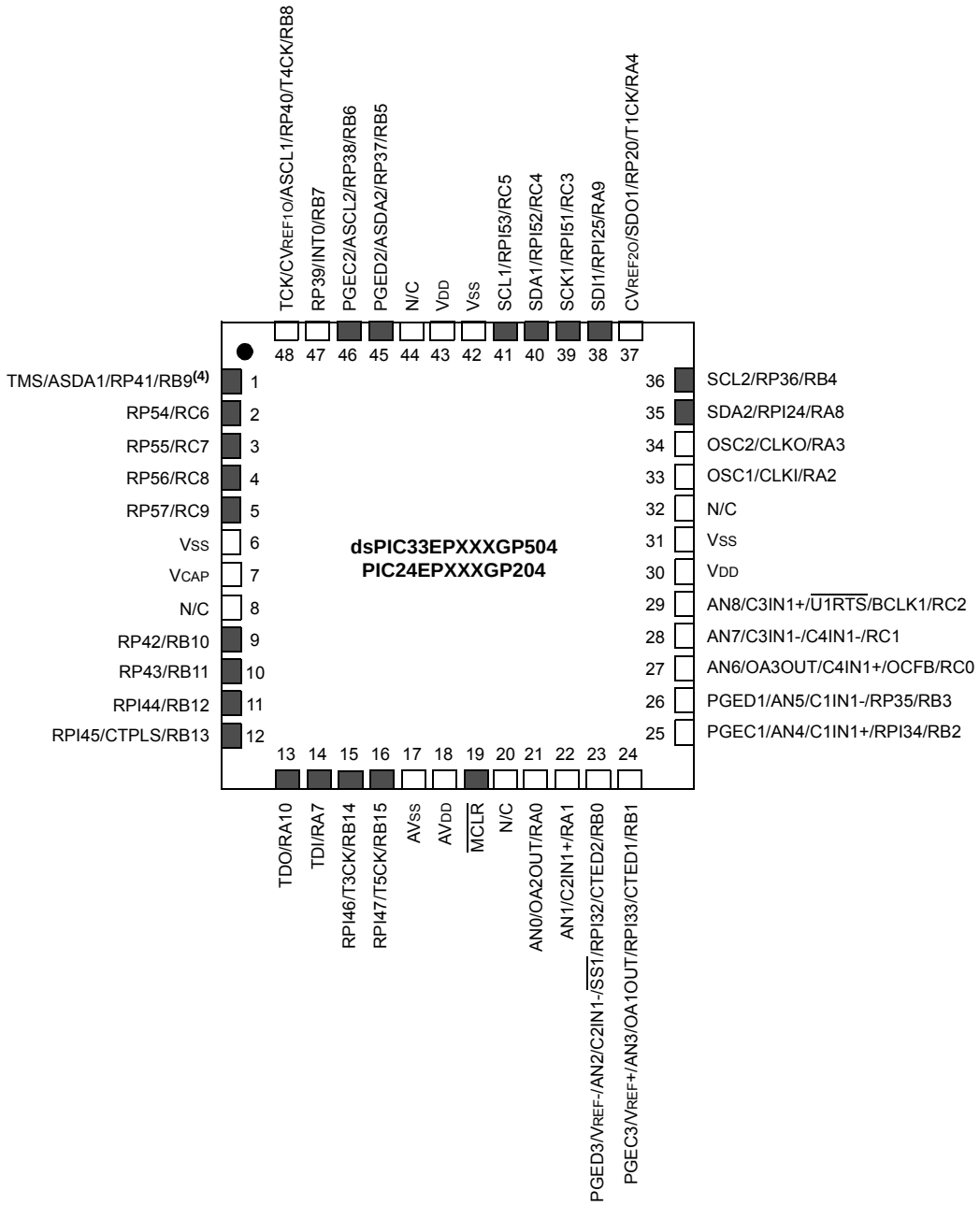
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	dsPIC
Core Size	16-Bit
Speed	60 MIPs
Connectivity	I²C, IrDA, LINbus, QEI, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, Motor Control PWM, POR, PWM, WDT
Number of I/O	35
Program Memory Size	32KB (10.7K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	2K x 16
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 9x10b/12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	44-VQFN Exposed Pad
Supplier Device Package	44-QFN (8x8)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33ep32mc204t-e-ml

Pin Diagrams (Continued)

48-Pin UQFN(1,2,3)

■ = Pins are up to 5V tolerant



Note 1: The RPn/RPIn pins can be used by any remappable peripheral with some limitation. See **Section 11.4 "Peripheral Pin Select (PPS)"** for available peripherals and for information on limitations.

2: Every I/O port pin (RAx-RGx) can be used as a Change Notification pin (CNAx-CNGx). See **Section 11.0 "I/O Ports"** for more information.

3: The metal pad at the bottom of the device is not connected to any pins and is recommended to be connected to VSS externally.

4: There is an internal pull-up resistor connected to the TMS pin when the JTAG interface is active. See the JTAGEN bit field in Table 27-2.

4.2 Data Address Space

The dsPIC33EPXXXGP50X, dsPIC33EPXXXMC20X/50X and PIC24EPXXXGP/MC20X CPU has a separate 16-bit-wide data memory space. The Data Space is accessed using separate Address Generation Units (AGUs) for read and write operations. The data memory maps, which are presented by device family and memory size, are shown in Figure 4-7 through Figure 4-16.

All Effective Addresses (EAs) in the data memory space are 16 bits wide and point to bytes within the Data Space. This arrangement gives a base Data Space address range of 64 Kbytes (32K words).

The base Data Space address is used in conjunction with a Read or Write Page register (DSRPAG or DSWPAG) to form an Extended Data Space, which has a total address range of 16 Mbytes.

dsPIC33EPXXXGP50X, dsPIC33EPXXXMC20X/50X and PIC24EPXXXGP/MC20X devices implement up to 52 Kbytes of data memory (4 Kbytes of data memory for Special Function Registers and up to 48 Kbytes of data memory for RAM). If an EA points to a location outside of this area, an all-zero word or byte is returned.

4.2.1 DATA SPACE WIDTH

The data memory space is organized in byte-addressable, 16-bit-wide blocks. Data is aligned in data memory and registers as 16-bit words, but all Data Space EAs resolve to bytes. The Least Significant Bytes (LSBs) of each word have even addresses, while the Most Significant Bytes (MSBs) have odd addresses.

4.2.2 DATA MEMORY ORGANIZATION AND ALIGNMENT

To maintain backward compatibility with PIC® MCU devices and improve Data Space memory usage efficiency, the dsPIC33EPXXXGP50X, dsPIC33EPXXXMC20X/50X and PIC24EPXXXGP/MC20X instruction set supports both word and byte operations. As a consequence of byte accessibility, all Effective Address calculations are internally scaled to step through word-aligned memory. For example, the core recognizes that Post-Modified Register Indirect Addressing mode [Ws++] results in a value of Ws + 1 for byte operations and Ws + 2 for word operations.

A data byte read, reads the complete word that contains the byte, using the LSb of any EA to determine which byte to select. The selected byte is placed onto the LSB of the data path. That is, data memory and registers are organized as two parallel, byte-wide entities with shared (word) address decode but separate write lines. Data byte writes only write to the corresponding side of the array or register that matches the byte address.

All word accesses must be aligned to an even address. Misaligned word data fetches are not supported, so care must be taken when mixing byte and word operations, or translating from 8-bit MCU code. If a misaligned read or write is attempted, an address error trap is generated. If the error occurred on a read, the instruction underway is completed. If the error occurred on a write, the instruction is executed but the write does not occur. In either case, a trap is then executed, allowing the system and/or user application to examine the machine state prior to execution of the address Fault.

All byte loads into any W register are loaded into the LSB. The MSB is not modified.

A Sign-Extend (SE) instruction is provided to allow user applications to translate 8-bit signed data to 16-bit signed values. Alternatively, for 16-bit unsigned data, user applications can clear the MSB of any W register by executing a Zero-Extend (ZE) instruction on the appropriate address.

4.2.3 SFR SPACE

The first 4 Kbytes of the Near Data Space, from 0x0000 to 0x0FFF, is primarily occupied by Special Function Registers (SFRs). These are used by the dsPIC33EPXXXGP50X, dsPIC33EPXXXMC20X/50X and PIC24EPXXXGP/MC20X core and peripheral modules for controlling the operation of the device.

SFRs are distributed among the modules that they control and are generally grouped together by module. Much of the SFR space contains unused addresses; these are read as '0'.

Note:	The actual set of peripheral features and interrupts varies by the device. Refer to the corresponding device tables and pinout diagrams for device-specific information.

4.2.4 NEAR DATA SPACE

The 8-Kbyte area, between 0x0000 and 0x1FFF, is referred to as the Near Data Space. Locations in this space are directly addressable through a 13-bit absolute address field within all memory direct instructions. Additionally, the whole Data Space is addressable using MOV instructions, which support Memory Direct Addressing mode with a 16-bit address field, or by using Indirect Addressing mode using a working register as an Address Pointer.

TABLE 4-6: INTERRUPT CONTROLLER REGISTER MAP FOR dsPIC33EPXXXMC20X DEVICES ONLY

File Name	Addr.	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
IFS0	0800	—	DMA1IF	AD1IF	U1TXIF	U1RXIF	SPI1IF	SPI1EIF	T3IF	T2IF	OC2IF	IC2IF	DMA0IF	T1IF	OC1IF	IC1IF	INT0IF	0000
IFS1	0802	U2TXIF	U2RXIF	INT2IF	T5IF	T4IF	OC4IF	OC3IF	DMA2IF	—	—	—	INT1IF	CNIF	CMIF	MI2C1IF	SI2C1IF	0000
IFS2	0804	—	—	—	—	—	—	—	—	—	IC4IF	IC3IF	DMA3IF	—	—	SPI2IF	SPI2EIF	0000
IFS3	0806	—	—	—	—	—	QEI1IF	PSEMIF	—	—	—	—	—	—	MI2C2IF	SI2C2IF	—	0000
IFS4	0808	—	—	CTMUIF	—	—	—	—	—	—	—	—	—	CRCIF	U2EIF	U1EIF	—	0000
IFS5	080A	PWM2IF	PWM1IF	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IFS6	080C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	PWM3IF	0000
IFS8	0810	JTAGIF	ICDIF	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IFS9	0812	—	—	—	—	—	—	—	—	—	PTG3IF	PTG2IF	PTG1IF	PTG0IF	PTGWDTIF	PTGSTEPIF	—	0000
IEC0	0820	—	DMA1IE	AD1IE	U1TXIE	U1RXIE	SPI1IE	SPI1EIE	T3IE	T2IE	OC2IE	IC2IE	DMA0IE	T1IE	OC1IE	IC1IE	INT0IE	0000
IEC1	0822	U2TXIE	U2RXIE	INT2IE	T5IE	T4IE	OC4IE	OC3IE	DMA2IE	—	—	—	INT1IE	CNIE	CMIE	MI2C1IE	SI2C1IE	0000
IEC2	0824	—	—	—	—	—	—	—	—	—	IC4IE	IC3IE	DMA3IE	—	—	SPI2IE	SPI2EIE	0000
IEC3	0826	—	—	—	—	—	QEI1IE	PSEMIE	—	—	—	—	—	—	MI2C2IE	SI2C2IE	—	0000
IEC4	0828	—	—	CTMUIE	—	—	—	—	—	—	—	—	—	CRCIE	U2EIE	U1EIE	—	0000
IEC5	082A	PWM2IE	PWM1IE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IEC6	082C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	PWM3IE	0000
IEC8	0830	JTAGIE	ICDIE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IEC9	0832	—	—	—	—	—	—	—	—	—	PTG3IE	PTG2IE	PTG1IE	PTG0IE	PTGWDTIE	PTGSTEPIE	—	0000
IPC0	0840	—	T1IP<2:0>			—	OC1IP<2:0>			—	IC1IP<2:0>			—	INT0IP<2:0>			4444
IPC1	0842	—	T2IP<2:0>			—	OC2IP<2:0>			—	IC2IP<2:0>			—	DMA0IP<2:0>			4444
IPC2	0844	—	U1RXIP<2:0>			—	SPI1IP<2:0>			—	SPI1EIP<2:0>			—	T3IP<2:0>			4444
IPC3	0846	—	—	—	—	—	DMA1IP<2:0>			—	AD1IP<2:0>			—	U1TXIP<2:0>			0444
IPC4	0848	—	CNIP<2:0>			—	CMIP<2:0>			—	MI2C1IP<2:0>			—	SI2C1IP<2:0>			4444
IPC5	084A	—	—	—	—	—	—	—	—	—	—	—	—	—	INT1IP<2:0>			0004
IPC6	084C	—	T4IP<2:0>			—	OC4IP<2:0>			—	OC3IP<2:0>			—	DMA2IP<2:0>			4444
IPC7	084E	—	U2TXIP<2:0>			—	U2RXIP<2:0>			—	INT2IP<2:0>			—	T5IP<2:0>			4444
IPC8	0850	—	—	—	—	—	C1RXIP<2:0>			—	SPI2IP<2:0>			—	SPI2EIP<2:0>			0444
IPC9	0852	—	—	—	—	—	IC4IP<2:0>			—	IC3IP<2:0>			—	DMA3IP<2:0>			0444
IPC12	0858	—	—	—	—	—	MI2C2IP<2:0>			—	SI2C2IP<2:0>			—	—	—	—	0440
IPC14	085C	—	—	—	—	—	QEI1IP<2:0>			—	PSEMIP<2:0>			—	—	—	—	0440
IPC16	0860	—	CRCIP<2:0>			—	U2EIP<2:0>			—	U1EIP<2:0>			—	—	—	—	4440
IPC19	0866	—	—	—	—	—	—	—	—	—	CTMUIP<2:0>			—	—	—	—	0040
IPC23	086E	—	PWM2IP<2:0>			—	PWM1IP<2:0>			—	—	—	—	—	—	—	—	4400
IPC24	0870	—	—	—	—	—	—	—	—	—	—	—	—	—	PWM3IP<2:0>			0004

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-31: PERIPHERAL PIN SELECT INPUT REGISTER MAP FOR dsPIC33EPXXXGP50X DEVICES ONLY

File Name	Addr.	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
RPINR0	06A0	—	INT1R<6:0>							—	—	—	—	—	—	—	—	0000
RPINR1	06A2	—	—	—	—	—	—	—	—	—	INT2R<6:0>							0000
RPINR3	06A6	—	—	—	—	—	—	—	—	—	T2CKR<6:0>							0000
RPINR7	06AE	—	IC2R<6:0>							—	IC1R<6:0>							0000
RPINR8	06B0	—	IC4R<6:0>							—	IC3R<6:0>							0000
RPINR11	06B6	—	—	—	—	—	—	—	—	—	OCFAR<6:0>							0000
RPINR18	06C4	—	—	—	—	—	—	—	—	—	U1RXR<6:0>							0000
RPINR19	06C6	—	—	—	—	—	—	—	—	—	U2RXR<6:0>							0000
RPINR22	06CC	—	SCK2INR<6:0>							—	SDI2R<6:0>							0000
RPINR23	06CE	—	—	—	—	—	—	—	—	—	SS2R<6:0>							0000
RPINR26	06D4	—	—	—	—	—	—	—	—	—	C1RXR<6:0>							0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-32: PERIPHERAL PIN SELECT INPUT REGISTER MAP FOR dsPIC33EPXXXMC50X DEVICES ONLY

File Name	Addr.	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
RPINR0	06A0	—	INT1R<6:0>							—	—	—	—	—	—	—	—	0000
RPINR1	06A2	—	—	—	—	—	—	—	—	—	INT2R<6:0>							0000
RPINR3	06A6	—	—	—	—	—	—	—	—	—	T2CKR<6:0>							0000
RPINR7	06AE	—	IC2R<6:0>							—	IC1R<6:0>							0000
RPINR8	06B0	—	IC4R<6:0>							—	IC3R<6:0>							0000
RPINR11	06B6	—	—	—	—	—	—	—	—	—	OCFAR<6:0>							0000
RPINR12	06B8	—	FLT2R<6:0>							—	FLT1R<6:0>							0000
RPINR14	06BC	—	QEB1R<6:0>							—	QEA1R<6:0>							0000
RPINR15	06BE	—	HOME1R<6:0>							—	INDX1R<6:0>							0000
RPINR18	06C4	—	—	—	—	—	—	—	—	—	U1RXR<6:0>							0000
RPINR19	06C6	—	—	—	—	—	—	—	—	—	U2RXR<6:0>							0000
RPINR22	06CC	—	SCK2INR<6:0>							—	SDI2R<6:0>							0000
RPINR23	06CE	—	—	—	—	—	—	—	—	—	SS2R<6:0>							0000
RPINR26	06D4	—	—	—	—	—	—	—	—	—	C1RXR<6:0>							0000
RPINR37	06EA	—	SYNCI1R<6:0>							—	—	—	—	—	—	—	—	0000
RPINR38	06EC	—	DTCMP1R<6:0>							—	—	—	—	—	—	—	—	0000
RPINR39	06EE	—	DTCMP3R<6:0>							—	DTCMP2R<6:0>							0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-46: PORTA REGISTER MAP FOR PIC24EPXXXGP/MC206 AND dsPIC33EPXXXGP/MC206/506 DEVICES ONLY

File Name	Addr.	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
TRISA	0E00	—	—	—	TRISA12	TRISA11	TRISA10	TRISA9	TRISA8	TRISA7	—	—	TRISA4	—	—	TRISA1	TRISA0	1F93
PORTA	0E02	—	—	—	RA12	RA11	RA10	RA9	RA8	RA7	—	—	RA4	—	—	RA1	RA0	0000
LATA	0E04	—	—	—	LATA12	LATA11	LATA10	LATA9	LATA8	LATA7	—	—	LATA4	—	—	LA1TA1	LA0TA0	0000
ODCA	0E06	—	—	—	ODCA12	ODCA11	ODCA10	ODCA9	ODCA8	ODCA7	—	—	ODCA4	—	—	ODCA1	ODCA0	0000
CNENA	0E08	—	—	—	CNIEA12	CNIEA11	CNIEA10	CNIEA9	CNIEA8	CNIEA7	—	—	CNIEA4	—	—	CNIEA1	CNIEA0	0000
CNPUA	0E0A	—	—	—	CNPUA12	CNPUA11	CNPUA10	CNPUA9	CNPUA8	CNPUA7	—	—	CNPUA4	—	—	CNPUA1	CNPUA0	0000
CNPDA	0E0C	—	—	—	CNPDA12	CNPDA11	CNPDA10	CNPDA9	CNPDA8	CNPDA7	—	—	CNPDA4	—	—	CNPDA1	CNPDA0	0000
ANSELA	0E0E	—	—	—	ANSA12	ANSA11	—	—	—	—	—	—	ANSA4	—	—	ANSA1	ANSA0	1813

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-47: PORTB REGISTER MAP FOR PIC24EPXXXGP/MC206 AND dsPIC33EPXXXGP/MC206/506 DEVICES ONLY

File Name	Addr.	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
TRISB	0E10	TRISB15	TRISB14	TRISB13	TRISB12	TRISB11	TRISB10	TRISB9	TRISB8	TRISB7	TRISB6	TRISB5	TRISB4	TRISB3	TRISB2	TRISB1	TRISB0	FFFF
PORTB	0E12	RB15	RB14	RB13	RB12	RB11	RB10	RB9	RB8	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0	xxxx
LATB	0E14	LATB15	LATB14	LATB13	LATB12	LATB11	LATB10	LATB9	LATB8	LATB7	LATB6	LATB5	LATB4	LATB3	LATB2	LATB1	LATB0	xxxx
ODCB	0E16	ODCB15	ODCB14	ODCB13	ODCB12	ODCB11	ODCB10	ODCB9	ODCB8	ODCB7	ODCB6	ODCB5	ODCB4	ODCB3	ODCB2	ODCB1	ODCB0	0000
CNENB	0E18	CNIEB15	CNIEB14	CNIEB13	CNIEB12	CNIEB11	CNIEB10	CNIEB9	CNIEB8	CNIEB7	CNIEB6	CNIEB5	CNIEB4	CNIEB3	CNIEB2	CNIEB1	CNIEB0	0000
CNPUB	0E1A	CNPUB15	CNPUB14	CNPUB13	CNPUB12	CNPUB11	CNPUB10	CNPUB9	CNPUB8	CNPUB7	CNPUB6	CNPUB5	CNPUB4	CNPUB3	CNPUB2	CNPUB1	CNPUB0	0000
CNPDB	0E1C	CNPDB15	CNPDB14	CNPDB13	CNPDB12	CNPDB11	CNPDB10	CNPDB9	CNPDB8	CNPDB7	CNPDB6	CNPDB5	CNPDB4	CNPDB3	CNPDB2	CNPDB1	CNPDB0	0000
ANSELB	0E1E	—	—	—	—	—	—	—	ANSB8	—	—	—	—	ANSB3	ANSB2	ANSB1	ANSB0	010F

Legend: x = unknown value on Reset, — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-48: PORTC REGISTER MAP FOR PIC24EPXXXGP/MC206 AND dsPIC33EPXXXGP/MC206/506 DEVICES ONLY

File Name	Addr.	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
TRISC	0E20	TRISC15	—	TRISC13	TRISC12	TRISC11	TRISC10	TRISC9	TRISC8	TRISC7	TRISC6	TRISC5	TRISC4	TRISC3	TRISC2	TRISC1	TRISC0	BFFF
PORTC	0E22	RC15	—	RC13	RC12	RC11	RC10	RC9	RC8	RC7	RC6	RC5	RC4	RC3	RC2	RC1	RC0	xxxx
LATC	0E24	LATC15	—	LATC13	LATC12	LATC11	LATC10	LATC9	LATC8	LATC7	LATC6	LATC5	LATC4	LATC3	LATC2	LATC1	LATC0	xxxx
ODCC	0E26	ODCC15	—	ODCC13	ODCC12	ODCC11	ODCC10	ODCC9	ODCC8	ODCC7	ODCC6	ODCC5	ODCC4	ODCC3	ODCC2	ODCC1	ODCC0	0000
CNENC	0E28	CNIEC15	—	CNIEC13	CNIEC12	CNIEC11	CNIEC10	CNIEC9	CNIEC8	CNIEC7	CNIEC6	CNIEC5	CNIEC4	CNIEC3	CNIEC2	CNIEC1	CNIEC0	0000
CNPUC	0E2A	CNPUC15	—	CNPUC13	CNPUC12	CNPUC11	CNPUC10	CNPUC9	CNPUC8	CNPUC7	CNPUC6	CNPUC5	CNPUC4	CNPUC3	CNPUC2	CNPUC1	CNPUC0	0000
CNPDC	0E2C	CNPDC15	—	CNPDC13	CNPDC12	CNPDC11	CNPDC10	CNPDC9	CNPDC8	CNPDC7	CNPDC6	CNPDC5	CNPDC4	CNPDC3	CNPDC2	CNPDC1	CNPDC0	0000
ANSELC	0E2E	—	—	—	—	ANSC11	—	—	—	—	—	—	—	—	ANSC2	ANSC1	ANSC0	0807

Legend: x = unknown value on Reset, — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

REGISTER 5-2: NVMADRH: NONVOLATILE MEMORY ADDRESS REGISTER HIGH

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
NVMADR<23:16>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-8 **Unimplemented:** Read as '0'

bit 7-0 **NVMADR<23:16>:** Nonvolatile Memory Write Address High bits

Selects the upper 8 bits of the location to program or erase in program Flash memory. This register may be read or written by the user application.

REGISTER 5-3: NVMADRL: NONVOLATILE MEMORY ADDRESS REGISTER LOW

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
NVMADR<15:8>							
bit 15							bit 8

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
NVMADR<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **NVMADR<15:0>:** Nonvolatile Memory Write Address Low bits

Selects the lower 16 bits of the location to program or erase in program Flash memory. This register may be read or written by the user application.

REGISTER 5-4: NVMKEY: NONVOLATILE MEMORY KEY

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

W-0	W-0	W-0	W-0	W-0	W-0	W-0	W-0
NVMKEY<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-8 **Unimplemented:** Read as '0'

bit 7-0 **NVMKEY<7:0>:** Key Register (write-only) bits

REGISTER 7-4: INTCON2: INTERRUPT CONTROL REGISTER 2

R/W-1	R/W-0	R/W-0	U-0	U-0	U-0	U-0	U-0
GIE	DISI	SWTRAP	—	—	—	—	—
bit 15							bit 8

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0
—	—	—	—	—	INT2EP	INT1EP	INT0EP
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 15 **GIE:** Global Interrupt Enable bit
1 = Interrupts and associated IE bits are enabled
0 = Interrupts are disabled, but traps are still enabled

bit 14 **DISI:** DISI Instruction Status bit
1 = DISI instruction is active
0 = DISI instruction is not active

bit 13 **SWTRAP:** Software Trap Status bit
1 = Software trap is enabled
0 = Software trap is disabled

bit 12-3 **Unimplemented:** Read as ‘0’

bit 2 **INT2EP:** External Interrupt 2 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

bit 1 **INT1EP:** External Interrupt 1 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

bit 0 **INT0EP:** External Interrupt 0 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

REGISTER 9-1: OSCCON: OSCILLATOR CONTROL REGISTER(1) (CONTINUED)

bit 4 **Unimplemented:** Read as '0'

bit 3 **CF:** Clock Fail Detect bit(3)
- 1 = FSCM has detected clock failure
- 0 = FSCM has not detected clock failure

bit 2-1 **Unimplemented:** Read as '0'

bit 0 **OSWEN:** Oscillator Switch Enable bit
- 1 = Requests oscillator switch to selection specified by the NOSC<2:0> bits
- 0 = Oscillator switch is complete

Note 1: Writes to this register require an unlock sequence. Refer to **"Oscillator"** (DS70580) in the *"dsPIC33/PIC24 Family Reference Manual"* (available from the Microchip web site) for details.

2: Direct clock switches between any primary oscillator mode with PLL and FRCPLL mode are not permitted. This applies to clock switches in either direction. In these instances, the application must switch to FRC mode as a transitional clock source between the two PLL modes.

3: This bit should only be cleared in software. Setting the bit in software (= 1) will have the same effect as an actual oscillator failure and trigger an oscillator failure trap.

14.2 Input Capture Registers

REGISTER 14-1: ICxCON1: INPUT CAPTURE x CONTROL REGISTER 1

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	U-0	U-0
—	—	ICSIDL	ICTSEL2	ICTSEL1	ICTSEL0	—	—
bit 15							bit 8

U-0	R/W-0	R/W-0	R/HC/HS-0	R/HC/HS-0	R/W-0	R/W-0	R/W-0
—	ICI1	ICI0	ICOV	ICBNE	ICM2	ICM1	ICM0
bit 7							bit 0

Legend:	HC = Hardware Clearable bit	HS = Hardware Settable bit	
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-14 **Unimplemented:** Read as '0'

bit 13 **ICSIDL:** Input Capture Stop in Idle Control bit
- 1 = Input capture will Halt in CPU Idle mode
- 0 = Input capture will continue to operate in CPU Idle mode

bit 12-10 **ICTSEL<2:0>:** Input Capture Timer Select bits
- 111 = Peripheral clock (FP) is the clock source of the ICx
- 110 = Reserved
- 101 = Reserved
- 100 = T1CLK is the clock source of the ICx (only the synchronous clock is supported)
- 011 = T5CLK is the clock source of the ICx
- 010 = T4CLK is the clock source of the ICx
- 001 = T2CLK is the clock source of the ICx
- 000 = T3CLK is the clock source of the ICx

bit 9-7 **Unimplemented:** Read as '0'

bit 6-5 **ICI<1:0>:** Number of Captures per Interrupt Select bits (this field is not used if ICM<2:0> = 001 or 111)
- 11 = Interrupt on every fourth capture event
- 10 = Interrupt on every third capture event
- 01 = Interrupt on every second capture event
- 00 = Interrupt on every capture event

bit 4 **ICOV:** Input Capture Overflow Status Flag bit (read-only)
- 1 = Input capture buffer overflow occurred
- 0 = No input capture buffer overflow occurred

bit 3 **ICBNE:** Input Capture Buffer Not Empty Status bit (read-only)
- 1 = Input capture buffer is not empty, at least one more capture value can be read
- 0 = Input capture buffer is empty

bit 2-0 **ICM<2:0>:** Input Capture Mode Select bits
- 111 = Input capture functions as interrupt pin only in CPU Sleep and Idle modes (rising edge detect only, all other control bits are not applicable)
- 110 = Unused (module is disabled)
- 101 = Capture mode, every 16th rising edge (Prescaler Capture mode)
- 100 = Capture mode, every 4th rising edge (Prescaler Capture mode)
- 011 = Capture mode, every rising edge (Simple Capture mode)
- 010 = Capture mode, every falling edge (Simple Capture mode)
- 001 = Capture mode, every edge rising and falling (Edge Detect mode (ICI<1:0>) is not used in this mode)
- 000 = Input capture module is turned off

REGISTER 17-19: INT1HLDH: INTERVAL 1 TIMER HOLD HIGH WORD REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
INTHLD<31:24>							
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
INTHLD<23:16>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **INTHLD<31:16>:** Hold Register for Reading and Writing INT1TMRH bits

REGISTER 17-20: INT1HLDL: INTERVAL 1 TIMER HOLD LOW WORD REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
INTHLD<15:8>							
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
INTHLD<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **INTHLD<15:0>:** Hold Register for Reading and Writing INT1TMRL bits

REGISTER 18-2: SPIxCON1: SPIx CONTROL REGISTER 1 (CONTINUED)

bit 4-2 **SPRE<2:0>:** Secondary Prescale bits (Master mode)(3)
111 = Secondary prescale 1:1
110 = Secondary prescale 2:1
•
•
•
000 = Secondary prescale 8:1

bit 1-0 **PPRE<1:0>:** Primary Prescale bits (Master mode)(3)
11 = Primary prescale 1:1
10 = Primary prescale 4:1
01 = Primary prescale 16:1
00 = Primary prescale 64:1

Note 1: The CKE bit is not used in Framed SPI modes. Program this bit to '0' for Framed SPI modes (FRMEN = 1).
2: This bit must be cleared when FRMEN = 1.
3: Do not set both primary and secondary prescalers to the value of 1:1.

REGISTER 21-10: CxCFG2: ECANx BAUD RATE CONFIGURATION REGISTER 2

U-0	R/W-x	U-0	U-0	U-0	R/W-x	R/W-x	R/W-x
—	WAKFIL	—	—	—	SEG2PH2	SEG2PH1	SEG2PH0
bit 15							bit 8

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
SEG2PHTS	SAM	SEG1PH2	SEG1PH1	SEG1PH0	PRSEG2	PRSEG1	PRSEG0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 **Unimplemented:** Read as '0'

bit 14 **WAKFIL:** Select CAN Bus Line Filter for Wake-up bit
1 = Uses CAN bus line filter for wake-up
0 = CAN bus line filter is not used for wake-up

bit 13-11 **Unimplemented:** Read as '0'

bit 10-8 **SEG2PH<2:0>:** Phase Segment 2 bits
111 = Length is 8 x TQ
•
•
•
000 = Length is 1 x TQ

bit 7 **SEG2PHTS:** Phase Segment 2 Time Select bit
1 = Freely programmable
0 = Maximum of SEG1PHx bits or Information Processing Time (IPT), whichever is greater

bit 6 **SAM:** Sample of the CAN Bus Line bit
1 = Bus line is sampled three times at the sample point
0 = Bus line is sampled once at the sample point

bit 5-3 **SEG1PH<2:0>:** Phase Segment 1 bits
111 = Length is 8 x TQ
•
•
•
000 = Length is 1 x TQ

bit 2-0 **PRSEG<2:0>:** Propagation Time Segment bits
111 = Length is 8 x TQ
•
•
•
000 = Length is 1 x TQ

REGISTER 21-17: CxRXFnEID: ECANx ACCEPTANCE FILTER n EXTENDED IDENTIFIER REGISTER (n = 0-15)

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
EID15	EID14	EID13	EID12	EID11	EID10	EID9	EID8
bit 15							bit 8

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
EID7	EID6	EID5	EID4	EID3	EID2	EID1	EID0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **EID<15:0>:** Extended Identifier bits
1 = Message address bit, EIDx, must be '1' to match filter
0 = Message address bit, EIDx, must be '0' to match filter

REGISTER 21-18: CxFMSKSEL1: ECANx FILTER 7-0 MASK SELECTION REGISTER 1

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
F7MSK<1:0>		F6MSK<1:0>		F5MSK<1:0>		F4MSK<1:0>	
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
F3MSK<1:0>		F2MSK<1:0>		F1MSK<1:0>		F0MSK<1:0>	
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-14 **F7MSK<1:0>:** Mask Source for Filter 7 bits
11 = Reserved
10 = Acceptance Mask 2 registers contain mask
01 = Acceptance Mask 1 registers contain mask
00 = Acceptance Mask 0 registers contain mask

bit 13-12 **F6MSK<1:0>:** Mask Source for Filter 6 bits (same values as bits<15:14>)

bit 11-10 **F5MSK<1:0>:** Mask Source for Filter 5 bits (same values as bits<15:14>)

bit 9-8 **F4MSK<1:0>:** Mask Source for Filter 4 bits (same values as bits<15:14>)

bit 7-6 **F3MSK<1:0>:** Mask Source for Filter 3 bits (same values as bits<15:14>)

bit 5-4 **F2MSK<1:0>:** Mask Source for Filter 2 bits (same values as bits<15:14>)

bit 3-2 **F1MSK<1:0>:** Mask Source for Filter 1 bits (same values as bits<15:14>)

bit 1-0 **F0MSK<1:0>:** Mask Source for Filter 0 bits (same values as bits<15:14>)

NOTES:

TABLE 27-1: CONFIGURATION BYTE REGISTER MAP

File Name	Address	Device Memory Size (Kbytes)	Bits 23-8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	0057EC	32	—	—	—	—	—	—	—	—	—
	00AFEC	64									
	0157EC	128									
	02AFEC	256									
	0557EC	512									
Reserved	0057EE	32	—	—	—	—	—	—	—	—	—
	00AFEE	64									
	0157EE	128									
	02AFEE	256									
	0557EE	512									
FICD	0057F0	32	—	Reserved(3)	—	JTAGEN	Reserved(2)	Reserved(3)	—	ICS<1:0>	
	00AFF0	64									
	0157F0	128									
	02AFF0	256									
	0557F0	512									
FPOR	0057F2	32	—	WDTWIN<1:0>		ALTI2C2	ALTI2C1	Reserved(3)	—	—	—
	00AFF2	64									
	0157F2	128									
	02AFF2	256									
	0557F2	512									
FWDT	0057F4	32	—	FWDTEN	WINDIS	PLLKEN	WDTPRE	WDTPOST<3:0>			
	00AFF4	64									
	0157F4	128									
	02AFF4	256									
	0557F4	512									
FOSC	0057F6	32	—	FCKSM<1:0>		IOL1WAY	—	—	OSCIOFNC	POSCMD<1:0>	
	00AFF6	64									
	0157F6	128									
	02AFF6	256									
	0557F6	512									
FOSCSEL	0057F8	32	—	IESO	PWMLOCK(1)	—	—	—	FNOSC<2:0>		
	00AFF8	64									
	0157F8	128									
	02AFF8	256									
	0557F8	512									
FGS	0057FA	32	—	—	—	—	—	—	—	GCP	GWRP
	00AFFA	64									
	0157FA	128									
	02AFFA	256									
	0557FA	512									
Reserved	0057FC	32	—	—	—	—	—	—	—	—	—
	00AFFC	64									
	0157FC	128									
	02AFFC	256									
	0557FC	512									
Reserved	057FFE	32	—	—	—	—	—	—	—	—	—
	00AFFE	64									
	0157FE	128									
	02AFFE	256									
	0557FE	512									

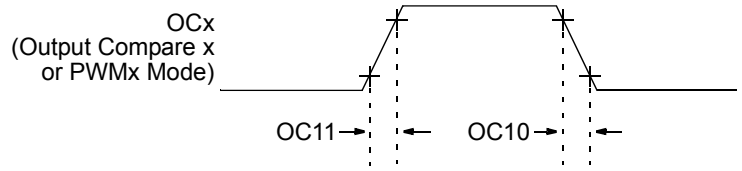
Legend: — = unimplemented, read as '1'.

Note 1: This bit is only available on dsPIC33EPXXXMC20X/50X and PIC24EPXXXMC20X devices.

2: This bit is reserved and must be programmed as '0'.

3: These bits are reserved and must be programmed as '1'.

FIGURE 30-7: OUTPUT COMPARE x MODULE (OCx) TIMING CHARACTERISTICS



Note: Refer to Figure 30-1 for load conditions.

TABLE 30-27: OUTPUT COMPARE x MODULE TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
OC10	TccF	OCx Output Fall Time	—	—	—	ns	See Parameter DO32
OC11	TccR	OCx Output Rise Time	—	—	—	ns	See Parameter DO31

Note 1: These parameters are characterized but not tested in manufacturing.

FIGURE 30-8: OCx/PWMx MODULE TIMING CHARACTERISTICS

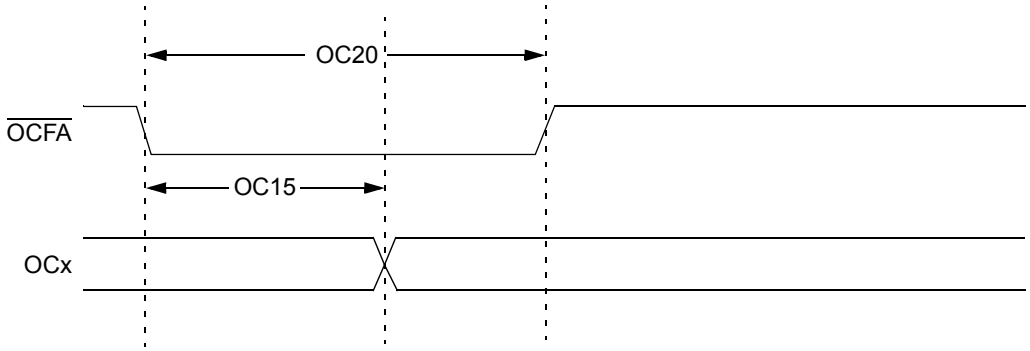


TABLE 30-28: OCx/PWMx MODE TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
OC15	TFD	Fault Input to PWMx I/O Change	—	—	TCY + 20	ns	
OC20	TFLT	Fault Input Pulse Width	TCY + 20	—	—	ns	

Note 1: These parameters are characterized but not tested in manufacturing.

TABLE 30-48: SPI1 SLAVE MODE (FULL-DUPLEX, CKE = 0, CKP = 0, SMP = 0) TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.(2)**	**Max.**	**Units**	**Conditions**
SP70	FscP	Maximum SCK1 Input Frequency	—	—	11	MHz	**(Note 3)**
SP72	TscF	SCK1 Input Fall Time	—	—	—	ns	See Parameter DO32 **(Note 4)**
SP73	TscR	SCK1 Input Rise Time	—	—	—	ns	See Parameter DO31 **(Note 4)**
SP30	TdoF	SDO1 Data Output Fall Time	—	—	—	ns	See Parameter DO32 **(Note 4)**
SP31	TdoR	SDO1 Data Output Rise Time	—	—	—	ns	See Parameter DO31 **(Note 4)**
SP35	TscH2doV, TscL2doV	SDO1 Data Output Valid after SCK1 Edge	—	6	20	ns	
SP36	TdoV2scH, TdoV2scL	SDO1 Data Output Setup to First SCK1 Edge	30	—	—	ns	
SP40	TdiV2scH, TdiV2scL	Setup Time of SDI1 Data Input to SCK1 Edge	30	—	—	ns	
SP41	TscH2diL, TscL2diL	Hold Time of SDI1 Data Input to SCK1 Edge	30	—	—	ns	
SP50	TssL2scH, TssL2scL	$\overline{SS1}$ ↓ to SCK1 ↑ or SCK1 ↓ Input	120	—	—	ns	
SP51	TssH2doZ	$\overline{SS1}$ ↑ to SDO1 Output High-Impedance	10	—	50	ns	**(Note 4)**
SP52	TscH2ssH, TscL2ssH	$\overline{SS1}$ ↑ after SCK1 Edge	1.5 TCY + 40	—	—	ns	**(Note 4)**

Note 1: These parameters are characterized, but are not tested in manufacturing.

2: Data in "Typical" column is at 3.3V, +25°C unless otherwise stated.

3: The minimum clock period for SCK1 is 91 ns. Therefore, the SCK1 clock generated by the master must not violate this specification.

4: Assumes 50 pF load on all SPI1 pins.

FIGURE 30-34: ECANx MODULE I/O TIMING CHARACTERISTICS

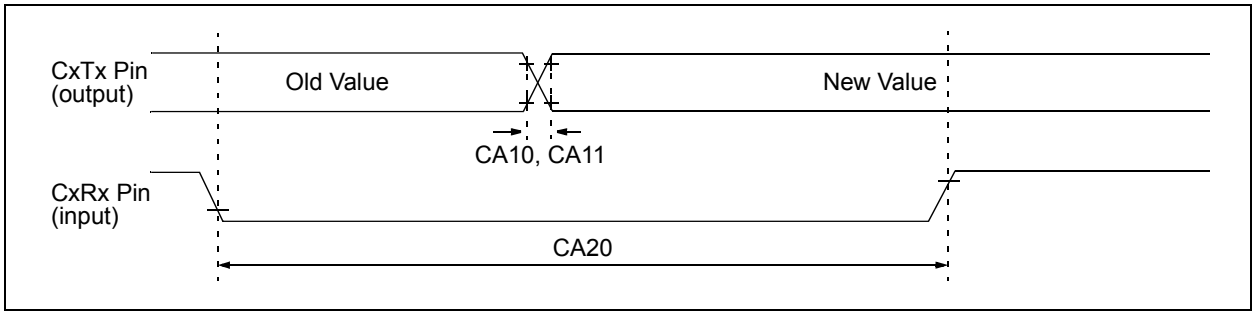


TABLE 30-51: ECANx MODULE I/O TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.(2)**	**Max.**	**Units**	**Conditions**
CA10	TIOF	Port Output Fall Time	—	—	—	ns	See Parameter DO32
CA11	TIOR	Port Output Rise Time	—	—	—	ns	See Parameter DO31
CA20	TCWF	Pulse Width to Trigger CAN Wake-up Filter	120	—	—	ns	

Note 1: These parameters are characterized but not tested in manufacturing.

2: Data in "Typical" column is at 3.3V, +25°C unless otherwise stated. Parameters are for design guidance only and are not tested.

FIGURE 30-35: UARTx MODULE I/O TIMING CHARACTERISTICS

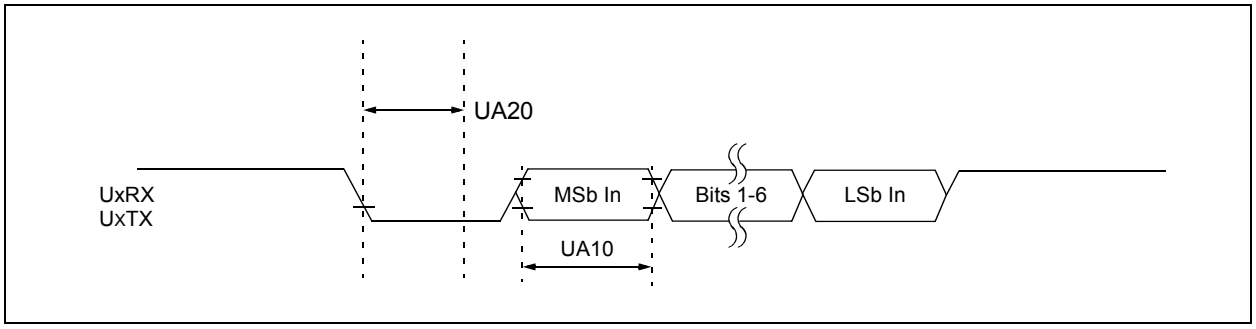


TABLE 30-52: UARTx MODULE I/O TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +125°C				
Param No.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.(2)**	**Max.**	**Units**	**Conditions**
UA10	TUABAUD	UARTx Baud Time	66.67	—	—	ns	
UA11	FBAUD	UARTx Baud Frequency	—	—	15	Mbps	
UA20	TCWF	Start Bit Pulse Width to Trigger UARTx Wake-up	500	—	—	ns	

Note 1: These parameters are characterized but not tested in manufacturing.

2: Data in "Typical" column is at 3.3V, +25°C unless otherwise stated. Parameters are for design guidance only and are not tested.

32.0 DC AND AC DEVICE CHARACTERISTICS GRAPHS

Note: The graphs provided following this note are a statistical summary based on a limited number of samples and are provided for design guidance purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore, outside the warranted range.

FIGURE 32-1: VOH – 4x DRIVER PINS

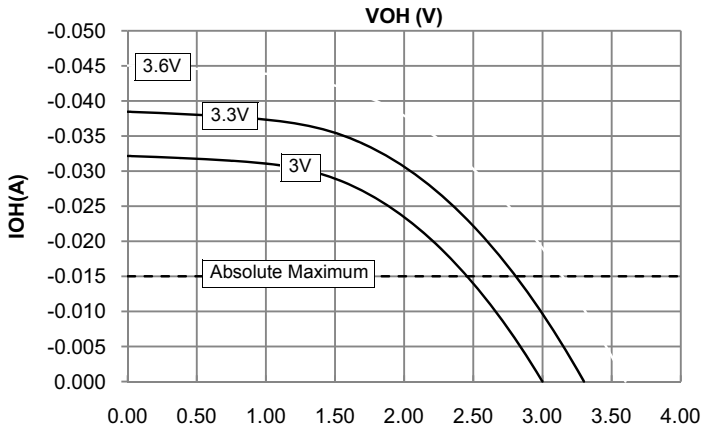


FIGURE 32-2: VOH – 8x DRIVER PINS

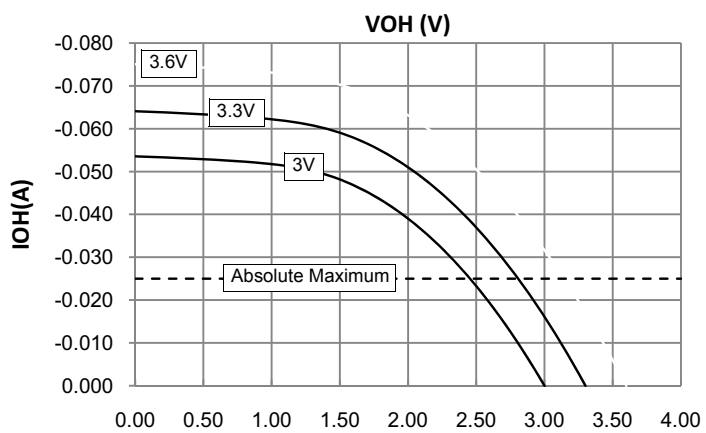


FIGURE 32-3: VOL – 4x DRIVER PINS

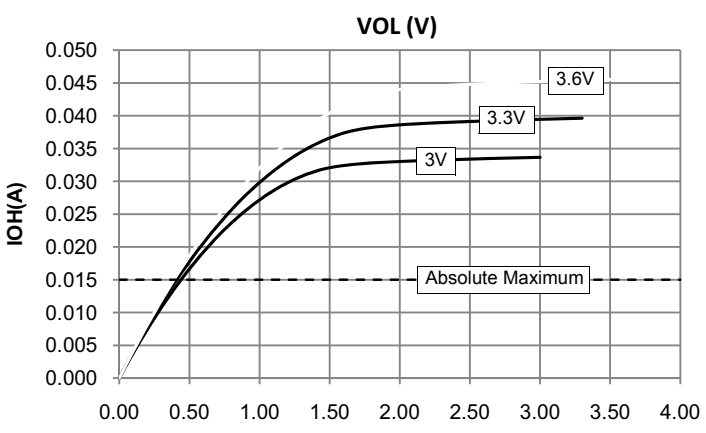
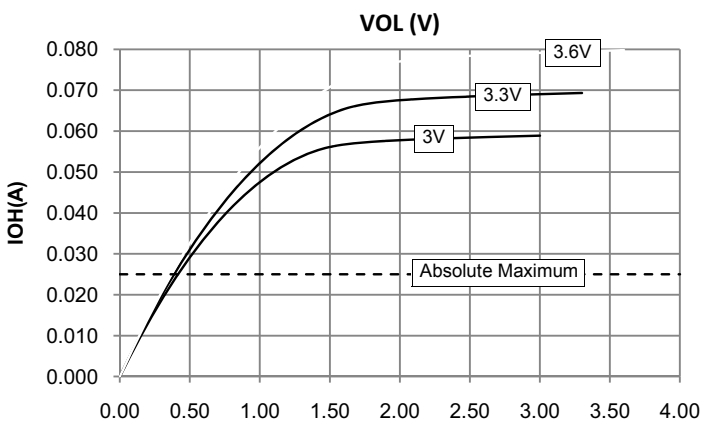
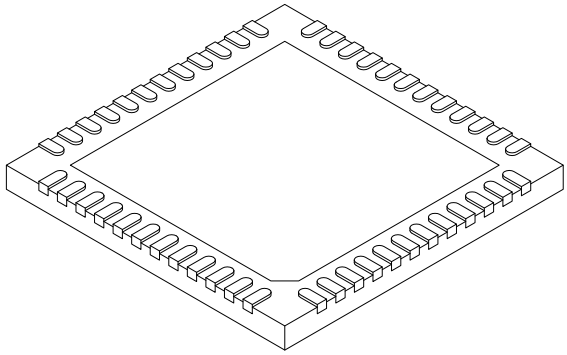


FIGURE 32-4: VOL – 8x DRIVER PINS



48-Lead Plastic Ultra Thin Quad Flat, No Lead Package (MV) – 6x6x0.5 mm Body [UQFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		48	
Pitch	e		0.40 BSC	
Overall Height	A	0.45	0.50	0.55
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.127 REF	
Overall Width	E		6.00 BSC	
Exposed Pad Width	E2	4.45	4.60	4.75
Overall Length	D		6.00 BSC	
Exposed Pad Length	D2	4.45	4.60	4.75
Contact Width	b	0.15	0.20	0.25
Contact Length	L	0.30	0.40	0.50
Contact-to-Exposed Pad	K	0.20	-	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated.
3. Dimensioning and tolerancing per ASME Y14.5M.

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

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